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HYDROCARBON MEASUREMENT DISCREPANCIES AMONG VARIOUS ANALYZERS USING FLAME-IONIZATION DETECTORS

Frank F. McElroy, et al

Environmental Monitoring and Support Laboratory
Research Triangle Park, North Carolina

September 1975

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Several experimenters have observed substantially discrepant nonmethane hydrocarbon measurements from various types of hydrocarbon analyzers measuring identical samples of ambient air. To formally investigate this problem, an experimental laboratory study wherein a number of flame-ionization analyzers were observed under controlled conditions while making simultaneous measurements of urban ambient air was conducted. Substantial discrepancies were found to occur among different models of analyzers. The standard deviations of these discrepancies averaged 0.322 part per million, which is extremely large with respect to the ambient air quality standard (guide) for nonmethane hydrocarbons, 0.24 part per million.

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by

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HYDROCARBON MEASUREMENT DISCREPANCIES AMONG VARIOUS ANALYZERS USING FLAME-IONIZATION DETECTORS

BACKGROUND

Efforts to measure hydrocarbon concentrations in the atmosphere date back to the early 1950's or earlier. Continuous, routine monitoring of ambient total hydrocarbon concentrations by air pollution control agencies came into common practice in the early 1960's, when commercial total hydrocarbon analyzers became available. Virtually all of these later analyzers employed a flame-ionization detector (FID) wherein hydrocarbon compounds were measured by detecting their ionization in a hydrogen flame. The response of these FID analyzers was related not only to the concentration of the hydrocarbon being measured, but also to the "effective carbon number" of the hydrocarbon compound. The effective carbon number varied depending on the number of carbon atoms in the molecule and on the type of compound (e.g., aliphatic, aromatic, olefinic, acetylenic, etc.). Thus, without knowing which hydrocarbon compound was being measured, the reading could not be related to the actual concentration. Some FID technologists further pointed out that there may also be still other problems that could cause discrepancies in response from one flame-ionization detector to another.

But these problems were mitigated in the 1960's for several reasons: (1) the ambient air could contain a great variety and number of individual hydrocarbon compounds, (2) there was incomplete knowledge of the relative importance, as pollutants, of the various hydrocarbons that might occur in ambient air, (3) a large fraction of the total hydrocarbons in the air was methane, which was measured relatively well by the flame ionization analyzers (FIA), (4) no hydrocarbon standards existed, and (5) no satisfactory alternative methodologies appeared to be available. Over the years, the measurement of total hydrocarbons--and later "hydrocarbons corrected for methane"--came to be defined in terms of the response of the FID.[1]

Interest in hydrocarbon measurements waxed as more was learned about the role of hydrocarbons in photochemical reactions with other pollutants, and particularly in the formation of ozone. When it appeared that ambient methane did not taken an active part in these

reactions, attention was focused on nonmethane hydrocarbons (NMHC), sometimes referred to as "reactive hydrocarbons." Methods were developed to continuously measure ambient methane concentrations and these measurements could than be subtracted from concurrent total hydrocarbon (THC) measurements to obtain NMHC. A National Ambient Air Quality Standard for hydrocarbons (actually NMHC) was promulgated.[2] Although this standard was "for use as a guide," it was considerably lower than many of the NMHC concentrations that were being observed in urban ambient air. The frequent exceeding of the standard started serious questioning of the credibility of both the standard and of the measurement methodology.

Development of methods to measure methane and NMHC was relatively slow. The definition of NMHC in terms of the FID and the impracticability of attempting to measure individual hydrocarbons virtually ruled out methodology not based on the FID. Early systems employing columns of activated carbon were fraught with problems and often produced numerous negative readings.[3] When it was demonstrated that gas chromatography could be used effectively to separate and measure methane accurately, a chromatographic method was designated as the reference method.[2] But while methane could be measured chromatographically, total hydrocarbons could not. And although commercially available gas chromatographic-type instruments provided measurements of both methane and total hydrocarbons (to yield a NMHC measurement) only the methane measurement was actually made by chromatographic separation. The THC measurement still had to be made more or less directly by the instrument's FID without benefit of the gas chromatographic process. Thus NMHC measurements were somewhat better, but measurement errors were still large with respect to the ambient air quality standard for NMHC. Moreover, commercial gas chromatographic analyzers for NMHC proved to be complex, expensive, and sometimes unreliable. They also required high levels of operator skill, careful maintenance, and high purity of several support gases usually needed for operation. Since there was no requirement to monitor NMHC, states were not encouraged to purchase NMHC monitors for use in their State Implementation Plan (SIP) networks.

Recent advances in hydrocarbon measurement technology have resulted in somewhat more accurate hydrocarbon monitors. Gas chromatographic-

type instruments have become less complex, less costly, and more reliable. New types of instruments use non-gas-chromatographic methods for separating methane from total hydrocarbons to effect the NMHC measurement. Many of these new analyzers are easier to operate and have improved stability.

But problems remain. To date, no method has yet been developed to remove methane from the THC in order to measure the NMHC concentration directly. Thus, all present methods require the measurement of total hydrocarbon and methane concentrations separately, determining the NMHC concentration by subtraction. This necessitates use of scale ranges for both THC and methane of at least 10 parts per million (ppm) to avoid off-scale readings in typical urban air. Normal calibration and measurement errors are increased by the necessity of making two measurements. These errors are large with respect to typical NMHC concentrations, which generally are below 2 or 3 ppm. Such errors can be very large with respect to the 0.24 ppm NMHC standard.[4]

Still another problem is reported by several experimenters who have observed substantially discrepant NMHC measurements from various types of hydrocarbon analyzers measuring identical samples of ambient air (Appendix A).[5] This phenomenon is apparently due to the variation in response to different hydrocarbon substances among various FID's. Again, this problem is relatively small when measuring THC because of the large fraction of methane, but can become far more significant in the NMHC measurements. Moreover, the magnitude of the discrepancies from one FID to another changes as the proportion of various hydrocarbons in the ambient air changes from hour to hour.

ANALYZER STUDY

This last problem of inconsistancy from one FID to another appeared to be inherent in the FID technology, and the reported discrepancies from analyzer to analyzer were considerable. Such discrepancies or variations would have a possibly serious impact on the NMHC reference method and on any attempts to determine whether alternate methods are equivalent to the reference method.[6] To further and formally investigate this problem, an experimental laboratory study was designed wherein a number of FIA's could be observed under controlled conditions

while making simultaneous measurements of urban ambient air. The objectives of this experiment were (1) to confirm the existence of this discrepancy problem under carefully controlled conditions of operation and calibration, (2) to determine the magnitude and significance of the problem with respect to NMHC measurements in quasi-typical urban ambient air, and (3) to attempt to better define the nature and possible causes of the problem. The scope of the experiment was necessarily quite limited because of limitations on time and available analyzers.

Experimental Design

The experiment was conducted at the Durham Air Monitoring and Demonstration Facility (DAMDF) in Durham, North Carolina, a location that can be considered to have more or less typical urban air. Measurements were collected in late October and early November, during which time total hydrocarbon concentrations varied from very low (less than 2.0 ppm) to high (up to 8 ppm).

The objectives of the experiment implied that NMHC measurements of identical samples of urban ambient air be collected and compared for a variety of FIA's. However, for several important reasons to be explained shortly, total hydrocarbon measurements were collected from the analyzers and pseudo-NMHC values were analyzed and compared.

Discrepancies among simultaneous NMHC measurements from various analyzers could arise from a number of sources. For hydrocarbon analyzers the significant sources are: (1) differences in calibration, (2) differences in calibration species (e.g., methane vs. ethane or propane), (3) presence of unknown concentrations of higher hydrocarbons in calibration standards, (4) differences in scale linearity, (5) differences in response times, (6) differences in drift and stability, (7) normal analyzer precision and repeatability errors, (8) differences in efficiency of separating methane from THC, and (9) differences in response to various higher hydrocarbon compounds and other organics. For the results of the experiment to be meaningful, this list of variables was reduced, as follows: Differences in calibration and calibration species were eliminated by calibrating all test analyzers simultaneously with the same calibration standard (supplied from a high-pressure cylinder). Methane was used because it was least likely to cause differences in FID response, was highly stable, and could be used to (simultaneously) cali-

brate both THC and methane responses. The standard used was methane in air with less than 0.1 ppm other hydrocarbons. Although the lack of higher hydrocarbons could not be absolutely confirmed, use of the same standard to calibrate all analyzers during the entire study would minimize this possibility as a source of discrepancy. Each of the analyzers was checked for linearity (with methane) to eliminate nonlinearity as a source of discrepancy; each analyzer proved to be linear within the normal calibration accuracy limits. Differences in response times were excluded as a source of discrepancy by using relatively long averaging times for the measurements -- all reported values were visually-determined one-hour averages (or half-hour averages in Table 1).

Discrepancies caused by differences in analyzer drift and stability were minimized (but certainly not eliminated) by careful daily zero and span adjustments to each analyzer, and by correcting the measurements when significant zero drift did occur. Variation due to analyzer precision and repeatability errors is inherent in the analyzer and could not be completely controlled.

The remaining two sources of discrepancy -- differences in the efficiency with which an analyzer separates methane from THC and differences in analyzer response to various higher hydrocarbon (NMHC) or other compounds -- were of primary interest because these sources, more than any others, are beyond the ability of the analyzer operator to control or correct. Limitations in the scope of the study and in the analyzers available permitted investigation of only the latter phenomenon -- difference in analyzer response. Accordingly, differences in methane separation efficiency were eliminated from the experiment by using only THC measurements from each of the analyzers. Concurrent methane measurements from one of the analyzers were used to calculate pseudo-NMHC concentrations for each analyzer. Using the same methane value for each analyzer, it is obvious that any discrepancies in the resulting NMHC measurement must be due solely to discrepancies in the THC measurement. However, the discrepancies are thereby put in perspective relative to NMHC measurements, not THC measurements; innocent-looking discrepancies in the THC measurements may become significant discrepancies with respect to the smaller NMHC measurements. This scheme also permitted the use of methane for the simultaneous calibration of all analyzers,

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Table 1. ARTIFICIAL ATMOSPHERE TEST

Pollutant	Approximate concentration, ppm	Equivalent CH_4 concentration, ppm	1/2-hour THC averages, ppm				
			Bendix 8201	MSA 11-2	Beck. 400-1	Beck. 400-2	Beck. 68000C
CH_4 (zero)	0.15	0.15	0.15	0.15	0.15	0.15	0.15
CH_4 (span)	8.05	8.05	8.05	8.05	8.05	8.05	8.05
C_2H_6/CH_4	1.97/0.9	4.84	5.1	5.9	5.7	5.8	6.3
			5.1	5.9	5.7	5.8	6.3
			5.0	5.8	5.65	5.6	6.2
			5.0	5.8	5.65	5.6	6.2
			4.97	5.77	5.65	5.75	6.22
			4.97	5.77	5.65	5.75	6.22
			5.0	5.77	5.6	5.7	6.1
C_2H_4/C_2H_2	1.9/1.9	7.6	6.4	4.85	7.35	7.35	7.3
			6.4	4.85	7.35	7.35	7.3
			6.4	4.9	7.35	7.35	7.3
			6.4	4.9	7.35	7.35	7.3
			6.4	4.8	7.4	7.5	7.45
			6.4	4.8	7.4	7.55	7.45
			6.4	4.8	7.4	7.55	7.45

and allowed the use of THC analyzers in the experiment. The latter was particularly important because two identical THC analyzers were available for the study, making it possible to compare discrepancies between like-model analyzers with those between different models.

The analyzers used for the experiment consisted of:

1. One Beckman Model 6800 Gas Chromatograph.
2. One MSA Model 11-2 Hydrocarbon Analyzer.
3. One Bendix Model 8201 Hydrocarbon Analyzer.
4. Two Beckman Model 400 Total Hydrocarbon Analyzers.

These analyzers all employed an FID detector and represented a variety of detector designs and operating characteristics. The Beckman 6800 is a gas chromatographic instrument presumably representative of the existing reference method for NMHC, and provides 12 batch-analyses per hour. The Bendix 8201 is also a batch-analysis type analyzer using gas chromatographic-colume-type separation of methane and providing 20 analyses per hour. The MSA 11-2 is a dual-FID continuous NMHC instrument using catalytic oxidation to separate methane. The Beckman 400's are simple, continuous, FID type THC analyzers having no capability to separate methane.

All analyzers were operated at the DAMDF where they were connected to a common sample air distribution manifold and measured ambient air during the field study. No artificial pollutant augmentation was used, although a short side-experiment with artificial HC concentration was also conducted. Data were recorded by strip chart recorders operating at 2.54 cm per hour (1 inch per hour) and were averaged and tabulated manually. Random checks on averaging and tabulation accuracy were made periodically by an alternate operator. The analyzers were zeroed and spanned daily, and standard linear interpolation corrections were made when significant zero drift was observed.

The Beckman 400 analyzers were modified for the study by replacing their bypass-type sample pressure regulators with dead-end-type regulators with a small constant-bypass flow. This modification was needed to reduce calibration gas consumption so that the entire experiment could be completed on a single cylinder of span gas. The instruments were later restored to their original condition to verify that the modification caused no significant change in their performance. The

Beckman 6800 operated erratically during part of the study and its data were not used until the last few days of the experiment. The MSA 11-2 did not have a THC output, but by operating it with the methane-measuring FID off, the NMHC output yielded THC measurements. The Bendix 8201 was used to provide the methane measurements.

Most FID analyzers, and all those used in this study, operate with a sample pump ahead of the FID to provide sample air to the detector under positive pressure. During calibration, the calibration standard gas is normally inserted under positive pressure between the pump and the analyzer. This assumes that the diaphram-type pump used does not change the hydrocarbon concentration of the sample air. This technique is commonly used and was used during the experiment. Afterwards, however, calibration gas was introduced into the normal sample air intake ahead of the pump using a vent system to prevent positive pressure. Unfortunately, differences were detected on two of the analyzers (the 6800 and the 11-2). No explanation for this phenomenon was determined. Appropriate corrections had to be made to the data from the affected analyzers (about -8 percent correction for the 11-2 and about -5 percent for the 6800).

Analysis of Results

There is no doubt that differences in response to various hydrocarbons exist among different FIA's. This phenomenon was indicated by the short side-experiment wherein two different artificial mixtures of hydrocarbons were measured by all five analyzers. Table 1 shows the results. When a mixture containing 1.97 ppm ethane (C_2H_6) and 0.9 ppm methane (CH_4),* equivalent to 4.84 ppm-carbon (1.97 x 2 + 0.9 = 4.84), was measured, the readings ranged from 4.97 ppm to 6.3 ppm. The two identical Beckman 400's agreed within 0.1 ppm. A mixture containing 1.9 ppm ethylene (C_2H_4) and 1.9 ppm acetylene (C_2H_2),* equivalent to 7.6 ppm-carbon, produced measurements ranging from 4.8 to 7.55 ppm -- a maximum discrepancy of 2.75 ppm! Again the two 400's agreed reasonably well. Interestingly, the analyzers producing the highest and lowest readings are different for the two mixtures.

*This was the supplier's analysis and was not verified.

Hourly average ambient THC measurements were collected from the test analyzers from October 25 to November 6, 1974. Concurrent methane measurements from the Bendix 8201 were also collected and used to calculate pseudo-NMHC values for each of the hourly THC measurements. These values were then compared statistically by computing the differences (discrepancies) for each of the ten analyzer pairs. The results are listed in detail in Appendix B and summarized in Tables 2 and 3. In Table 2, the "high" and "low" columns give the maximum positive and negative discrepancies, respectively, and indicate the range of the individual hourly discrepancies, some of which are quite large. The standard deviations of the discrepancies for the various analyzer pairs range from 0.217 to 0.454 ppm. This represents 2 to 4.5 percent of the full scale range and is very large with respect to the 0.24 ppm standard for NMHC. Eight of the ten 95 percent confidence intervals fail to include zero (and the other two are marginal) indicating that most of the analyzer pairs (including the identical Beckman 400's) are providing statistically different readings even when the correlation coefficient is high. Table 3 gives the cumulative frequency distribution for each of the analyzer pairs.

It can be noted that the data for the pair of Beckman 400's does not indicate significantly better performance than the other analyzer pairs. Also, there seems to be no strong correlation with differences noted in Table 1. These observations suggest that differences in FID response may contribute to, but apparently are not an overwhelming cause of discrepancies between various analyzers. If it is a cause, it probably is of a similar order of magnitude as other causes. Other causes not eliminated by the experiment are differences in drift and stability, and analyzer precision and repeatibility errors.

The standard deviations shown in Table 2 apply to the differences between various analyzer pairs and would therefore tend to overestimate the errors associated with any one analyzer's measurement. The standard deviations for individual analyzers cannot be determined from the study data, but they can be roughly approximated if the assumption is made that they are all nearly equal. Under this condition, the standard deviation for the individual analyzers would be approximated by the average standard deviation (0.322 ppm) divided by $\sqrt{2}$, or about 0.23 ppm.

Table 2. STATISTICAL ANALYSIS OF DISCREPANCIES BETWEEN PSEUDO-NMHC CONCENTRATIONS FROM VARIOUS PAIRS OF FID ANALYZERS

Comparison	Number	(ppm) High	Low	Mean	Std. dev.	95% Conf. int.	Corr. coef.
Beck. 6800 - MSA 11-2	96	0.85	-0.70	-0.091	0.217	-0.140, -0.051	0.980
Beck. 6800 - Ben. 8201	96	1.75	-0.20	+0.205	0.454	+0.113, +0.300	0.982
Beck. 6800 - Beck. 400-1	84	0.75	-1.80	-0.139	0.323	+0.209, -0.068	0.941
Beck. 6800 - Beck. 400-2	94	0.35	-1.30	-0.374	0.277	-0.431, -0.317	0.957
MSA 11-2 - Ben. 8201	215	2.50	-0.80	+0.371	0.389	+0.318, +0.424	0.925
MSA 11-2 - Beck. 400-1	181	0.80	-1.75	+0.036	0.248	-0.001, +0.073	0.935
MSA 11-2 - Beck. 400-2	191	1.75	-1.25	-0.136	0.308	-0.181, -0.092	0.888
Ben. 8201 - Beck. 400-1	181	0.10	-1.90	-0.306	0.353	-0.359, -0.253	0.934
Ben. 8201 - Beck. 400-2	191	0.50	-1.70	-0.461	0.360	-0.513, -0.409	0.897
Beck. 400-1 - Beck. 400-2	181	1.40	-1.30	-0.154	0.294	-0.198, -0.110	0.909
Average std. dev.					0.322		

Table 3. CUMULATIVE FREQUENCY DISTRIBUTION OF DISCREPANCIES
(percent of total readings)

Comparison	Discrepancy, ppm						
	0.0	0.1	0.2	0.3	0.4	0.5	1.0
Beck. 6800 - MSA 11-2	9.4	42.7	70.8	87.5	91.7	97.9	100.0
Beck. 6800 - Ben. 8201	15.6	47.9	69.8	72.9	74.0	80.2	92.7
Beck. 6800 - Beck. 400-1	9.5	36.9	71.4	82.1	90.5	92.9	97.6
Beck. 6800 - Beck. 400-2	2.1	6.4	19.1	42.6	60.6	73.4	97.9
MSA 11-2 - Ben. 8201	7.4	20.0	41.9	60.5	67.9	77.7	93.5
MSA 11-2 - Beck. 400-1	13.8	57.5	79.0	91.2	95.0	95.6	99.4
MSA 11-2 - Beck. 400-2	9.4	29.8	51.8	70.2	82.7	88.5	99.0
Ben. 8201 - Beck. 400-1	19.9	44.8	57.6	68.0	74.6	81.8	95.0
Ben. 8201 - Beck. 400-2	4.2	13.6	31.9	42.4	56.0	66.5	93.2
Beck. 400-1 - Beck. 400-2	14.4	37.0	66.3	74.0	88.9	93.4	98.3

On this basis, about 95 percent of the measurements would be within ± 0.46 ppm (two standardized deviations). This is 4.6 percent of the 10 ppm full-scale range -- not unusual for air monitoring instruments, but almost twice the 0.24-ppm standard, which is only 2.4 percent of the full-scale range. Obviously, it is difficult to measure concentrations below 1 ppm with a scale range of 10 ppm, and the 10-ppm range is necessary to include the normal range of ambient THC and methane concentrations. (The highest concentrations observed during the experiment were 8.9 ppm THC and 6.75 ppm methane.) This leads to the further observation, shown in Table 4, that the 6 to 9 a.m. average NMHC concentration exceeded the NMHC standard almost every day for which data were collected -- sometimes several-fold! Although all but the 8201 data are pseudo-NMHC data, the magnitude of the 3-hour averages cause great concern when compared to the 0.24-ppm standard.

In normal operation, when the analyzers would be making actual NMHC measurements, the discrepancies would be expected to be even larger because of variation in the methane measurements and from other variables that were controlled in this study. This suggests that the types of methods tested are apparently not adequate to measure ambient NMHC concentrations, particularly with respect to the Ambient Air Quality Standard for NMHC.

SUMMARY AND CONCLUSIONS

Substantial discrepancies occur among different models of flame-ionization hydrocarbon analyzers when measuring such compounds as ethane, ethylene, and actylene.

When measuring ambient air, discrepancies in hourly average pseudo-NMHC measurements exceeding 1 ppm were observed. The standard deviations of these discrepancies ranged from 0.217 to 0.454 ppm and averaged 0.322 ppm. In actual use, discrepancies would tend to be larger because of differences in methane separation efficiency and various routine operating factors, all of which were minimized or eliminated during this study.

Differences in response to various NMHC may contribute to the overall discrepancies, but are not an overriding cause. Drift, in-

Table 4. 6 to 9 a.m. NMHC CONCENTRATIONS
(NMHC Standard = 0.24 ppm)

Date	Beck. 6800	MSA 11-2	Ben. 8201	Beck. 400-1	Beck. 400-2	Avg.
10/26/74	--[a]	1.57	0.98	1.55	1.55	1.41
10/27/74	--[a]	0.52	0.22	0.32	0.42	0.37
10/28/74	--[a]	0.48	0.25	0.45	0.58	0.44
10/29/74	--[a]	1.07	0.65	1.38	1.15	1.06
10/30/74	--[a]	3.40	0.85	--[a]	--[a]	2.12
10/31/74	0.75	0.85	0.42	0.95	1.17	0.83
11/01/74	0.40	0.58	0.32	0.62	0.92	0.57
11/05/74	-0.08	0.08	0.15	--[a]	0.60	0.19
11/06/74	0.12	0.27	0.08	1.42	0.78	0.53

[a]No data available.

stability, precision, and repeatability errors are apparently the important causes of discrepancies.

When NMHC concentrations are determined by difference between THC and methane measurements, it is necessary to use scale ranges of at least 10 ppm. Thus the 5 to 10 percent (of 10-ppm full-scale range) discrepancies commonly observed are large with respect to the normal NMHC range of 0 to 2 ppm and extremely large with respect to the 0.24-ppm standard.

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5. Ortman, G. C. memo to Franz Burmann. April 12, 1974. Included herein as Appendix A.

6. 40 CFR Part 53 - Ambient Air Monitoring Reference and Equivalent Methods. Federal Register. 40(33):7044, February 18, 1975.

APPENDIX A: MEMO FROM G. C. ORTMAN

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SUBJECT: Identification of Problem (Hydrocarbons Corrected For Methane Methodology) DATE: April 12, 1974

FROM: Gordon C. Ortman

TO: Franz Burmann

THRU: Larry Purdue

Recent discrepancies in data obtained by hydrocarbon monitoring instrumentation have been brought to my attention by Vinson Thompson. More specifically, two commercial analyzers, viz., the Mine Safety Appliances (MSA) 11-2 and the Bendix 8201 reactive hydrocarbon analyzers, produce markedly different measurements of the non-methane fraction of the total hydrocarbon content of the ambient air. A side-by-side operation of the two analyzers has generated data reflecting ratios of hourly averaged data for "reactive" hydrocarbons of a magnitude at times greater than four to one. The anomaly is not attributable to instrument malfunction or improper calibration. Mr. Thompson has convinced me that he has conscientiously followed accepted procedures in conducting the tests. I am further advised Ralph Baumgardner of CPL has made similar observations and additionally has noted that the Beckman 6800 gas chromatograph on a common sample produced total hydrocarbon less methane values that were higher than the MSA readings and lower than the Bendix readings.

Early last week, I hypothesized that the phenomenon was attributable to the response characteristics of the detectors. I then visited our library and did a rapid literature search reading abstracts of patents dating back to the fifties and scanned the pages of a dozen or so articles all dealing with FID's. The hypothesis was tenable. Subsequently, I conferred with Mr. Poli of MSA, Mr. Leesberg of Bendix, and Drs. Perry and Lauer of International Rockwell. I also recalled a discussion with Messrs. Chapman and Villalobos of Beckman several months ago. Evidence exists in the minds of FID technologists and in the literature that one not only could but should find a disparity in the response characteristics of FID's having even very minor differences in design configuration or the same detector using different flow parameters. What has not been appreciated is the degree to which these differences can be manifested. My explanation for the lack of cognizance of the depth of the problem by the scientific world in general and the air pollution investigator in particular is that typically applicable reported research involved gas chromatographic analyzers equipped with FID's. Of necessity GC column variables, etc., dictated compound by compound calibration that tended to minimize detector peculiarities. I do not know of any in depth comparative studies of different total hydrocarbon analyzers used in ambient air analyses where methane was subtracted. Failure to subtract the methane would tend to mask the degree of nonuniformity of response to other hydrocarbons. This is true by virtue of the fact it is the predominant hydrocarbon in the atmosphere and methane is generally used

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to calibrate air monitoring analyzers, therewith insuring uniformity of response to it.

In summary, it is my conviction that whereas FID's probably respond reasonably uniformily to paraffins they vary significantly in their response to olefins, acetylenes, aromatics and other organics such as the alcohols, ketones and aldehydes. Present instrumentation does not allow legitimate comparison of total hydrocarbon less methane data collected by gas chromatographs designed to produce those data, such as the Beckman 6800, Bendix 8200, and Byron 200 series or the MSA 11-2 and the Bendix 8201.

To add to the complexity of the above stated problem is the recognized fact that the photochemical reactivity of different hydrocarbons varies tremendously.

It is my belief EPA must face up to the stated problem. There are solutions. But irrespective of the solution, I can not foresee any being free of arbitration. Until a solution is agreed upon, and backed by sound research, perpetuation of any numerical concentration limits for hydrocarbons corrected for methane now appears inane. Within this past week I have seen one analyzer produce readings that averaged for one hour a value of 0.22 ppm carbon and another analyzer producing a value in excess of an average of 1 ppm for the same time period for the same air sample.

ATTENTION

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APPENDIX B

OBS	DATE	MF	SKEW	HSA	SSM	PCK1	PCK2	CH4	JEB6	HS	PN	BEC1	BEF2	BB6S	BB8N	BB61	BB82	M	MSN	MSN	BEC1	BEF2	BB61
106	1029	12		3.00	3.00	3.0	3.50	2.85		.65	.35	.45	.65					.20	.20	.00	-.1	-.30	-.20
107	1029	13		3.35	2.00	3.0	3.00	2.95		.60	.25	.35	.35					.25	.25	.25	-.1	-.10	.00
108	1030	0		4.75	3.70			2.75		1.35	.95							1.00					
109	1030	1		6.55	5.00			3.75		2.90	1.75							1.05					
110	1030	2		6.55	5.00			4.75		1.30	.75							1.05					
111	1030	3			8.90			6.75			2.15												
112	1030	4			7.50			7.40			.25												
113	1030	5		8.15	8.00			6.45		1.70	1.75												
114	1030	6		7.00	7.00			6.25		.75	.75							-.05					
115	1030	7		8.50	8.00			5.25		3.25	.75							.00					
116	1027	8		7.55	5.50			4.45		3.20	1.10							2.50					
117	1030	9		7.10	5.55			4.45		2.65	1.10							2.10					
118	1030	10		2.70	2.40			2.25		.35	.15							1.55					
119	1030	11		2.70	2.00			1.85		.45	.15							.20					
120	1030	12																.30					
121	1030	13		2.40	1.75	1.7	1.80	1.05		.75	.05	.05	.15										
122	1030	14		2.40	1.70	1.7	1.80	1.65		.75	.05	-.05	.15					.70	.70	.60	.0	-.10	-.10
123	1030	15		2.40	1.70	1.7	1.70	1.60		.75	.05	.05	.05					.70	.80	.60	.1	-.10	-.20
124	1030	16	2.00	2.00	1.80	1.8	1.80	1.75	.25	.75	.05	.05	.05	-.50	.20	.20	.20	.70	.70	.70	.0	.00	.00
125	1030	17	2.80	2.70	2.40	2.5	2.50	1.90	.90	.75	.45	.55	.55	.15	.45	.35	.35	.70	.70	.70	.0	.00	.00
126	1030	18	2.00	2.00	2.00	2.0	2.00	1.95	.90	.85	.55	.65	.65	.05	.35	.25	.25	.30	.20	.20	-.1	-.10	.00
127	1030	19	5.00	4.00	4.00	5.0	5.50	3.75	3.40	2.55	1.65	2.65	3.15	.85	1.75	.75	.25	.30	.20	.20	-.1	-.10	.00
128	1030	20	5.40	5.00	4.10	5.0	5.40	3.80	2.90	2.85	1.55	2.75	2.85	.45	1.35	.15	.05	.90	-.10	-.60	-1.0	-1.50	-.50
129	1030	21	5.70	5.75	4.20	5.0	5.75	3.80	3.10	2.70	1.55	2.75	3.10	.40	1.55	.35	.00	.30	-.30	-.40	-1.2	-1.30	-.10
130	1030	22	6.00	5.55	4.50	5.0	5.85	3.90	3.15	2.70	1.65	2.95	3.00	.45	1.50	.20	.15	1.10	-.05	-.40	-1.2	-1.55	-.35
131	1030	23	5.00	4.00	4.00	5.0	5.25	3.90	2.05	1.95	1.05	2.45	2.30	.10	1.00	.05	.25	1.05	-.25	-.30	-1.3	-1.35	-.05
132	1031	0	3.00	3.15	2.60	3.0	3.30	2.00	.80	.90	.25	1.25	1.00	-.10	1.00	-.40	-.25	.90	-.50	-.35	-1.4	-1.25	.15
133	1031	1	2.70	2.70	2.30	2.7	2.90	1.95	.25	.75	.35	.75	.90	-.10	.55	-.45	-.25	.85	-.35	-.15	-1.0	-.80	.20
134	1031	2	2.10	2.30	2.00	2.4	2.00	1.80	.25	.45	.15	.55	.75	-.40	.00	-.40	-.60	.40	.00	-.20	-.4	-.60	-.20
135	1031	3	2.40	2.60	2.20	2.4	2.40	1.85	.45	.55	.25	.45	.95	-.20	.10	-.30	-.50	.20	-.10	-.30	-.4	-.60	-.20
136	1031	4	2.55	2.70	2.40	2.7	3.10	2.00	.30	.45	.15	.45	.95	-.10	.20	.00	-.40	.30	.10	-.30	-.2	-.60	-.40
137	1031	5	2.00	2.35	2.00	2.0	2.25	2.05	.80	.70	.25	.65	1.10	-.15	.15	-.15	-.55	.30	.00	-.40	-.3	-.70	-.40
138	1031	6	2.00	2.00	2.00	2.0	2.35	2.00	.80	.80	.35	.95	1.10	.10	.45	.15	-.30	.30	.05	-.40	-.3	-.70	-.45
139	1031	7	2.00	2.10	2.00	2.0	2.40	2.00	1.00	1.10	.55	1.05	1.40	.00	.45	-.15	-.30	.45	-.15	-.30	-.6	-.75	-.15
140	1031	8	2.00	2.00	2.00	2.0	2.30	1.90	-.10	.45	-.05	-.40	.55	-.10	.45	-.05	-.40	.55	.05	-.30	-.5	-.85	-.35
141	1031	9	2.00	2.00	1.90	2.0	2.40	1.75	.45	.65	.30	.85	1.00	-.20	.10	-.40	-.55	.30	-.20	-.35	-.5	-.85	-.15
142	1031	10		.25	.30	.15	.35	.65						-.05	.10	-.10	-.40	.15	-.05	-.35	-.2	-.50	-.30
143	1031	11	1.70	1.90	1.70	2.0	2.20	1.75	-.05	.20	-.05	.25	.45	-.25	.00	-.30	-.50	.25	-.05	-.25	-.3	-.50	-.20
144	1031	12	1.70	1.95	1.70	1.7	2.21	1.65	.05	.20	.05	.05	.56	-.15	.00	.00	-.51	.15	.15	-.36	.0	-.51	-.51
145	1031	13	1.90	1.95	1.70	1.6	2.00	1.65	-.05	.20	.05	-.05	.35	-.25	-.10	.00	-.40	.15	.25	-.15	.1	-.30	-.40
146	1031	14	1.90	1.85	1.70	1.7	2.10	1.85	.15	.20	.05	.05	.45	-.05	.10	.10	-.30	.15	.15	-.25	.0	-.40	-.40
147	1031	15	1.90	1.95	1.90	1.8	2.20	1.85	.25	.30	.15	.15	.55	-.05	.10	.10	-.30	.15	.15	-.25	.0	-.40	-.40
148	1031	16	2.10	2.10	1.90	2.1	2.40	1.85	.45	.50	.25	.45	1.75	-.05	.20	.00	-1.30	.25	.05	-1.25	-.2	-1.50	-1.30
149	1031	17	3.00	3.25	2.90	3.2	3.50	2.05	1.55	1.30	.85	1.20	1.45	.25	.70	.30	.10	.45	.05	-.15	-.4	-.60	-.20
150	1031	18	4.30	4.45	3.50	4.7	4.30	2.15	2.75	2.30	1.35	2.55	2.75	.45	1.40	.20	.00	.35	-.25	-.45	-1.2	-1.40	-.20
151	1031	19	3.80	3.80	3.10	3.9	4.30	2.15	1.65	1.65	.95	1.75	2.15	.00	.70	-.10	-.50	.70	-.10	-.50	-.8	-1.20	-.40
152	1031	20	3.50	3.60	2.80	3.5	3.30	2.05	1.45	1.55	.75	1.40	1.75	-.10	.70	.00	-.30	.80	.10	-.20	-.7	-1.00	-.30
153	1031	21	3.75	3.75	2.80	3.4	3.70	2.05	1.20	1.30	.75	1.35	1.65	-.10	.45	-.15	-.45	.55	-.05	-.35	-.6	-.90	-.30
154	1031	22	3.50	3.60	2.80	3.5	3.80	2.15	1.45	1.35	.85	1.15	1.55	.10	.80	.30	-.20	.70	.20	-.30	-.5	-1.00	-.50
155	1031	23	3.40	3.35	2.80	3.5	3.60	2.15	1.25	1.20	.65	1.30	1.40	.05	.60	-.10	-.20	.55	-.15	-.25	-.7	-.80	-.10
156	1027	0		3.05	2.70	2.9	3.10	2.45		.60	.25	.45	.65					.35	.15	-.05	-.2	-.40	-.20
157	1027	1		2.80	2.60	2.7	2.70	2.25		.45	.20	.35	.35					.20	.10	.10	-.1	-.10	.00
158	1027	2		2.60	2.70	2.5	2.90	2.15		.45	.15	.15	.35					.30	.30	.10	.0	-.20	-.20

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OBS	DATE	TIME	BECKMS	BECKNS	BECK1	BECK2	BECK4	BEDMS	BEDNS	BEC1	BEC2	BGMS	BGBEN	BGB1	BGB2	MSNF	MSB1	MSB2	BEFN1	BEFN2	B1B2
212	1028	9	4.90	4.50	5.5	4.50	3.25	1.65	1.25	2.25	1.25					.40	-.60	.40	-1.00	.00	1.00
213	1028	9	3.25	2.70	3.0	3.00	2.35	.90	.35	.65	.65					.55	.25	.25	-.30	-.30	.00
214	1028	10	2.40	2.20	2.3	2.20	2.05	.35	.15	.25	.25					.20	.10	.10	-.10	-.10	.00
215	1028	11																			
216	1028	12																			
217	1028	13	1.85	1.70			1.75	.10	-.05							.15					
218	1028	14	1.75	1.80			1.85	.20	.15							.05					
219	1028	15	1.85	1.70			1.65	.20	.05							.15					
220	1028	16	2.05	1.90			1.75	.30	.15							.15					
221	1028	17	2.60	2.70			1.85	.75	.45							.30					
222	1028	18	3.15	2.70			2.05	1.10	.65							.45					
223	1028	19	3.05	2.75			1.95	1.30	.75							.55					
224	1028	20	5.45	3.60			2.75	3.10	1.25							1.85					
225	1028	21	5.75	4.10			2.80	2.90	1.25							1.65					
226	1028	22	5.10	4.35			2.95	2.15	1.35							.80					
227	1028	23	7.10	5.90			3.05	3.45	1.35							2.10					
228	1101	0	3.00	3.60	3.00	3.7	3.90	2.05	1.35	1.35	.75	1.45	1.55	.00	.60	-.10	-.20	.60	-.10	-.20	-.70	-.80	-.10
229	1101	1	3.05	3.10	2.60	3.2	2.60	2.05	.80	.90	.35	.95	1.25	-.10	.45	-.15	-.45	.55	-.05	-.35	-.60	-.90	-.30
230	1101	2	2.75	3.05	2.50	3.0	2.20	2.10	.60	.90	.35	.85	1.05	-.30	.25	-.25	-.45	.55	.05	-.15	-.50	-.70	-.20
231	1101	3	3.05	3.05	2.90	3.1	3.00	2.75	.80	.80	.25	.85	1.05	.00	.55	-.05	-.25	.50	-.05	-.25	-.60	-.80	-.20
232	1101	4	2.95	3.70	3.40	3.7	3.20	2.15	.40	.55	.25	.55	1.15	-.15	.15	-.15	-.75	.30	.00	-.60	-.30	-.90	-.60
233	1101	5	2.40	3.60	3.30	3.5	3.70	2.10	.25	.45	.15	.35	.55	-.20	.10	-.10	-.30	.30	.10	-.10	-.20	-.40	-.20
234	1101	6	2.00	3.70	2.80	3.7	3.00	2.05	.60	.65	.45	.65	.95	-.05	.15	-.05	-.35	.20	.00	-.30	-.20	-.50	-.30
235	1101	7	2.30	3.60	2.70	3.7	2.90	1.95	.35	.65	.35	.75	.95	-.30	.00	-.40	-.60	.30	-.10	-.30	-.40	-.60	-.20
236	1101	8	2.00	3.40	2.10	2.4	2.80	1.95	.25	.45	.15	.45	.85	-.20	.10	-.20	-.60	.30	.00	-.40	-.30	-.70	-.40
237	1101	9	2.10	2.25	2.00	2.2	2.60	1.95	.25	.40	.15	.35	.75	-.15	.10	-.10	-.50	.25	.05	-.35	-.20	-.60	-.40
238	1101	10																					
239	1101	11	1.70	1.95	1.90	1.9	2.00	1.75	-.05	.20	.05	.15	.25	-.25	-.10	-.20	-.30	.15	.05	-.05	-.10	-.20	-.10
240	1101	12	1.70	1.85	1.70	1.8	1.90	1.85	-.05	.20	.05	.15	.35	-.15	.00	-.10	-.30	.15	.05	-.15	-.10	-.30	-.20
241	1101	13	1.70	1.85	1.70	1.7	2.10	1.85	.05	.20	.05	.05	.45	-.15	.00	.00	-.40	.15	.15	-.25	.00	-.40	-.40
242	1101	14	1.70	1.85	1.70	1.9	2.10	1.85	.05	.20	.05	.15	.45	-.15	.00	-.10	-.40	.15	.05	-.25	-.10	-.40	-.30
243	1101	15					1.75																
244	1101	16	1.80	1.95	1.90	1.9	2.40	1.85	.15	.30	.15	.15	.75	-.15	.00	.00	-.60	.15	.15	-.45	.00	-.60	-.60
245	1101	17	4.70	4.15	3.90	4.7	4.75	1.95	2.70	2.20	1.65	2.35	2.80	.55	1.10	.40	-.05	.55	-.15	-.60	-.70	-1.15	-.45
246	1101	18	6.80	5.45	4.70	5.7	6.00	2.25	3.55	3.20	2.05	3.45	3.75	.35	1.50	.10	-.20	1.15	-.25	-.55	-1.40	-1.70	-.30
247	1101	19	4.90	5.10	4.00	5.5	5.00	2.35	2.55	2.75	1.65	3.15	2.65	-.20	.90	-.60	-.10	1.10	-.40	.10	-1.50	-1.00	.50
248	1102	20	3.85	4.05	3.70	4.0	5.10	2.25	1.60	2.30	1.30	2.25	2.85	-.70	.30	-.65	-1.25	1.00	-.05	-.55	-.95	-1.55	-.60
249	1101	21	3.70	3.90	3.10	3.6	4.00	2.15	1.55	1.75	.95	1.45	1.85	-.20	.60	.10	-.30	.30	.30	-.10	-.50	-.90	-.40
250	1101	22	3.95	3.90	3.20	4.0	3.60	2.25	1.60	1.65	.95	1.75	1.35	-.05	.65	-.15	.25	.70	-.10	.30	-.80	-.40	.40
251	1101	23	3.05	3.50	2.80	3.7	3.00	2.15	.90	1.35	.05	1.35	1.05	-.45	.25	-.45	-.15	.70	.00	.30	-.70	-.40	.30

OBS	DATE	TIME	PCK3	MSA	PEN	BECK1	BECK2	CH4	PCS8	MS	BN	BEC1	BEC2	BMS	B6B8EN	B6B8B1	B6B8B2	MCEN	MS1	MSB2	BENB1	BENB2	B1B2
53	1105	4	1.5	1.60	1.7	1.7	2.10	1.05	-.15	-.05	.05	.05	.45	-.10	-.2	-.2	-.60	-.10	-.10	-.50	.0	-.40	-.40
54	1105	5	1.6	1.60	1.7	1.8	2.15	1.65	-.05	-.05	.05	.15	.50	.00	-.1	-.2	-.55	-.10	-.20	-.65	-.1	-.45	-.35
55	1105	6	1.6	1.70	1.7		2.05	1.75	-.15	-.05	-.05		.50	-.10	-.1		-.65	.00		-.55		-.55	
56	1105	7	1.7	1.85	1.9		2.25	1.75	-.15	.10	.05		.60	-.25	-.2		-.75	.05		-.50		-.55	
57	1105	8	1.7	1.85	1.8		2.35	1.05	.05	.20	.15		.70	-.15	-.1		-.65	.05		-.50		-.55	
58	1105	9	1.7	1.70	1.7			1.65	.05	.05	.05			.00	.0			.00					
59	1105	10		1.70	1.7			1.05		.05	.05							.00					
60	1105	11																					
61	1105	10	1.6	1.70	1.7			1.05	-.05	.05	.05			-.10	-.1			.00					
62	1105	17	1.6	1.70	1.7	1.8	2.00	1.07	-.05	.05	.05	.15	.35	-.10	-.1	-.2	-.40	.00	-.10	-.30	-.1	-.30	-.20
63	1105	14	1.6	1.70	1.7	1.7	1.90	1.65	-.05	.05	.05	.05	.25	-.10	-.1	-.1	-.30	.00	.00	-.20	.0	-.20	-.20
64	1105	15	1.7	1.85	1.9	1.8	2.00	1.65	.05	.20	.15	.15	.35	-.15	-.1	-.1	-.30	.05	.05	-.15	.0	-.20	-.20
65	1105	16	1.7	1.85	1.8	1.9	2.10	1.65	.05	.20	.15	.25	.45	-.15	-.1	-.2	-.40	.05	-.05	-.25	-.1	-.30	-.20
66	1105	17	1.6	1.85	1.9		2.20	1.65	-.05	.20	.15		.65	-.25	-.2		-.70	.05		-.45		-.50	
67	1105	18	1.5	1.70	1.7		2.00	1.65	-.15	.05	.05		.35	-.20	-.2		-.50	.00		-.30		-.30	
68	1105	19	1.5	1.70	1.6		1.90	1.65	-.15	.05	-.05		.25	-.20	-.1		-.40	.10		-.20		-.30	
69	1105	20	1.4	1.70	1.6	1.7	1.90	1.05	-.25	.05	-.05	.05	.25	-.30	-.2	-.3	-.50	.10	.00	-.20	-.1	-.30	-.20
70	1105	21	1.5	1.70	1.7	1.7	1.90	1.65	-.15	.05	.05	.05	.25	-.20	-.2	-.2	-.40	.00	.00	-.20	.0	-.20	-.20
71	1105	22	1.5	1.70	1.7	1.7	1.80	1.05	-.15	.05	.05	.05	.15	-.20	-.2	-.2	-.30	.00	.00	-.10	.0	-.10	-.10
72	1105	23	1.6	1.95	1.8	1.8	1.90	1.75	-.15	.10	.05	.05	.15	-.25	-.2	-.2	-.30	.05	.05	-.05	.0	-.10	-.10
73	1025	13		2.15																			
74	1025	14		2.15	1.9	1.8	2.30	1.75		.40	.15	.10	.55					.25	.25	-.15	.0	-.40	-.40
75	1025	15		2.15	1.9	1.8	2.30	1.75		.40	.15	.10	.55					.25	.25	-.15	.0	-.40	-.40
76	1025	16		2.15	1.9	2.0	2.40	1.75		.40	.15	.05	.65					.25	.15	-.25	-.1	-.50	-.40
77	1025	17		2.00	2.2	2.5	2.60	1.75		.85	.45	.75	.85					.40	.10	.00	-.3	-.40	-.10
78	1025	18		2.05	2.5	2.6	2.60	1.80		1.20	.85	1.15	1.15					.55	.05	.05	-.5	-.50	.00
79	1025	19		2.70	2.3	2.7	2.70	1.85		.85	.45	.85	.85					.40	.00	.00	-.4	-.40	.00
80	1025	20		2.35	2.9	3.0	2.70	1.95		1.40	.95	1.50	.75					.45	-.15	.05	-.5	.20	.80
81	1025	21		2.25	2.8	3.5	3.50	2.05		1.30	.75	1.45	1.45					.55	-.15	-.15	-.7	-.70	.00
82	1025	22		3.15	3.5	3.9	3.80	2.05		1.10	.45	.80	.95					.65	.25	.15	-.4	-.50	-.10
83	1025	23		2.70	2.3	2.5	2.70	1.95		.75	.35	.55	.75					.40	.20	.00	-.2	-.40	-.20
84	1026	0		2.80	2.5	2.8	3.00	2.05		.75	.45	.75	.95					.30	.00	-.20	-.3	-.50	-.20
85	1026	1		2.95	2.5	3.0	3.00	2.05		.90	.45	.95	.95					.45	-.05	-.05	-.5	-.50	.00
86	1026	2		3.15	2.7	3.2	3.20	2.05		.80	.35	.80	.85					.45	.15	.05	-.3	-.50	-.20
87	1026	3		3.05	2.6	2.9	3.20	2.15		.90	.45	.75	1.15					.45	.15	-.25	-.3	-.70	-.40
88	1026	4		3.00	2.8	3.4	3.60	2.05		.95	.45	.85	.95					.50	.10	.00	-.4	-.50	-.10
89	1026	5		3.50	2.9	3.4	3.70	2.45		1.65	.45	.85	1.25					.60	.10	-.20	-.5	-.80	-.30
90	1026	6		3.75	3.1	3.7	3.70	2.55		1.15	.55	1.15	1.15					.60	.00	.00	-.6	-.60	.00
91	1026	7		4.25	3.4	4.3	4.50	2.45		1.80	.95	1.85	2.05					.85	-.05	-.25	-.9	-1.10	-.20
92	1026	8		3.90	3.5	3.7	3.50	2.05		1.75	1.40	1.05	1.45					.30	.10	.20	-.2	.00	.20
93	1026	9		3.30	2.9	3.0	3.70	2.15		1.20	.75	1.15	1.55					.45	.05	-.35	-.4	-.80	-.40
94	1026	10		2.40	2.1	2.2	2.30	1.85		.45	.15	.00	.35					.30	.20	.10	-.1	-.20	-.10
95	1026	11		2.10	1.8	2.0	2.10	1.75		.40	.15	.20	.35					.05	.15	.05	-.1	-.20	-.10
96	1026	12		2.15	1.9	2.0	2.10	1.85		.50	.05	.15	.20					.25	.15	.05	-.1	-.20	-.10
97	1026	13		2.15	2.0	2.0	2.10	1.75		.30	.15	-.05	.25					.15	.25	.05	.1	-.10	-.20
98	1026	14		2.10	1.9	1.8	2.20	1.85		.20	.05	-.05	.35					.25	.35	-.05	.1	-.30	-.40
99	1026	15		2.05	1.9	1.8	2.20	1.75		.30	.15	.05	.45					.15	.25	-.15	.1	-.30	-.40
100	1026	16		2.05	2.1	2.3	2.60	1.95		.50	.15	.15	.65					.15	.15	-.35	.0	-.50	-.50
101	1026	17		2.40	2.2	2.2	2.80	2.05		.35	.15	.15	.35					.20	.20	-.60	.0	-.80	-.80
102	1026	18		2.05	2.9	3.0	3.90	2.15		1.20	.75	.95	.75					.35	.25	.35	-.1	.00	.10
103	1026	19		2.05	2.9	3.4	3.80	2.15		1.20	.75	.85	.85					.40	.35	.35	-.1	-.10	.00
104	1026	20		3.10	3.0	3.5	3.80	2.05		.70	.35	.85	.85					.35	-.15	-.15	-.5	-.50	.00
105	1026	21		3.50	3.0	3.2	3.50	2.05		.80	.25	.55	.85					.50	-.30	-.00	-.2	-.50	-.30

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			THC					NMHC					DESCREPANCIES								
						BECK1	BECK2		BE6S	BE6N	BE61	BE62	B6B8	B6S8	B6B6	B6B8	MSBE	MSB1	MSB2	NB1B2	B1B2
OBS	DATE	TIME	B6B8	B6SA	B6BN			CH4													
1	1106	0	1.8	1.85	1.7	1.8	2.00	1.65	-.05	.20	.05	.15	.35	-.25	-.1	-.2	-.40	.15	.05	-.15	-.1	-.30	-.20
2	1106	1	1.5	1.95	1.7	1.8	2.00	1.75	-.25	.10	-.05	.05	.25	-.35	-.2	-.3	-.50	.15	.05	-.15	-.1	-.30	-.20
3	1106	2	1.6	1.85	1.8	1.8	2.00	1.75	-.15	.10	.05	.05	.25	-.25	-.2	-.2	-.40	.05	.05	-.15	.0	-.20	-.20
4	1106	3	1.7	1.95	1.9	1.9	2.00	1.85	-.25	.10	-.05	.05	.15	-.25	-.1	-.2	-.30	.15	.05	-.05	-.1	-.20	-.10
5	1106	4	1.7	1.95	1.9	1.9	2.10	1.85	-.15	.10	.05	.05	.25	-.25	-.2	-.2	-.40	.05	.05	-.15	.0	-.20	-.20
6	1106	5	1.8	2.05	2.0	2.0	2.20	1.95	-.15	.10	.05	.05	.25	-.25	-.2	-.2	-.40	.05	.05	-.15	.0	-.20	-.20
7	1106	6	1.8	2.05	1.9	2.0	2.00	1.85	-.05	.20	.05	1.15	.75	-.25	-.1	-1.2	-.80	.15	-.95	-.55	-1.1	-.70	.40
8	1106	7	2.1	2.15	2.0	3.9	2.70	1.85	.25	.30	.15	2.05	.85	-.05	.1	-1.8	-.60	.15	-1.75	-.55	-1.9	-.70	1.20
9	1106	8	2.0	2.15	1.9	3.9	2.60	1.85	.15	.30	.05	1.05	.75	-.15	.1	-.9	-.60	.25	-.75	-.45	-1.0	-.70	.30
10	1106	9																					
11	1106	10																					
12	1106	11																					
13	1106	12																					
14	1106	13																					
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23	1106	22																					
24	1106	23																					
25	1104	0																					
26	1104	1																					
27	1104	2																					
28	1104	3																					
29	1104	4																					
30	1104	5																					
31	1104	6																					
32	1104	7																					
33	1104	8																					
34	1104	9																					
35	1104	10																					
36	1104	11		1.85	1.9	1.9	2.00	1.65		.20	.15	.15	.35					.05	.05	-.15	.0	-.20	-.20
37	1104	12	1.7	1.70	1.7	1.8	1.90	1.65	.05	.05	.05	.15	.25	.00	.0	-.1	-.20	.00	-.10	-.20	-.1	-.20	-.10
38	1104	13	1.7	1.70	1.7	1.8	1.90	1.65	.05	.05	.05	.15	.25	.00	.0	-.1	-.20	.00	-.10	-.20	-.1	-.20	-.10
39	1104	14	1.7	1.70	1.7	1.8	1.85	1.65	.05	.05	.05	.15	.20	.00	.0	-.1	-.15	.00	-.10	-.15	-.1	-.15	-.05
40	1104	15	1.7	1.85	1.7	1.8	1.85	1.65	.05	.20	.05	.15	.20	-.15	.0	-.1	-.15	.15	-.05	.00	-.1	-.15	-.05
41	1104	16	1.9	1.95	1.7	1.8	1.95	1.85	.10	.20	.05	.25	.30	-.05	.1	-.1	-.15	.15	-.05	-.10	-.2	-.25	-.05
42	1104	17	1.7	1.95	1.8	1.8	1.90	1.65	.05	.20	.15	.15	.30	-.15	-.1	-.1	-.25	.00	-.05	-.10	-.0	-.15	-.15
43	1104	18	1.9	1.95	1.7	1.8	2.10	1.85	.10	.20	.05	.15	.45	-.05	.1	.0	-.30	.15	.05	-.25	-.1	-.40	-.30
44	1104	19	1.7	1.95	1.7	1.9	2.10	1.65	.05	.20	.05	.25	.45	-.15	.0	-.2	-.40	.15	-.05	-.25	-.2	-.40	-.20
45	1104	20	1.8	1.70	1.7	1.8	2.10	1.65	-.05	.05	.05	.25	.45	-.10	-.1	-.3	-.50	.00	-.20	-.40	-.2	-.40	-.20
46	1104	21	1.8	1.70	1.7		2.10	1.65	-.05	.05	.05		.45	-.10	-.1		-.50	.00		-.40		-.40	
47	1104	22	1.8	1.70	1.8	1.8	2.15	1.65	-.05	.05	-.05	.15	.50	-.10	.0	-.2	-.55	.10	-.10	-.45	-.2	-.55	-.35
48	1104	23	1.5	1.75	1.8	1.7	2.15	1.65	-.15	.05	-.05	.05	.50	-.20	-.1	-.2	-.65	.10	.00	-.45	-.1	-.55	-.45
49	1105	0	1.8	1.80	1.7	1.7	2.15	1.65	-.15	-.05	.05	.05	.50	-.10	-.2	-.2	-.65	-.10	-.10	-.55	.0	-.45	-.45
50	1105	1	1.8	1.80	1.8		2.15	1.65	-.15	-.05	-.05		.50	-.10	-.1		-.65	.00		-.55		-.55	
51	1105	2	1.8	1.80	1.7		2.20	1.85	-.15	-.05	.05		.55	-.10	-.2		-.70	-.10		-.60		-.50	
52	1105	3	1.8	1.80	1.7		2.20	1.85	-.15	-.05	.05		.55	-.10	-.2		-.70	-.10		-.60		-.50	